A Literature Review on Ahp (Analytic Hierarchy Process)

Virendra Rajput[1], Dinesh Kumar[2], Arun Sharma[3], Shubham Singh[4], Rambhagat[5]

[1.] Asst. Prof. Dept. of Mechanical Engineering, Mittal Institute of Technology, Bhopal, Madhya Pradesh, India.
[2,3,4,5] UG Student, Dept. of Mechanical Engineering, Mittal Institute of Technology, Bhopal, Madhya Pradesh, India.
virendra.rajput89@gmail.com

Abstract This paper examines the pattern of development of the AHP research**.** The Analytic Hierarchy Process (AHP) was introduced by T.L. Saaty, is an effective tool for dealing with complex decision making, and may aid the decision maker to set priorities and make the best decision. The analytic hierarchy process (AHP) is a theory of measurement through pairwise comparisons and relies on the judgments of experts to derive priority scales, these scales that measure intangibles in relative terms. The ratio scales are derived from the principal Eigen vectors and the consistency index is derived from the principal Eigen value.

Key words: Analytic Hierarchy Process, Pairwise Comparisons, MCDM, Saaty scale

1. INTRODUCTION

In increasingly competitive markets, customer satisfaction is a vital corporate objective. Key elements to increasing customer satisfaction include producing consistently high quality products and providing high quality customer service. In addition, the intensive global competition among manufacturers to coordinate and respond quickly the industry value chain from suppliers to customers has made customer supplier relationship management important in the new business era. In such circumstances the decision making in each business plays a key role in the cost reduction, and supplier selection is one of the important functions in the supplier relationship management. Very few manufactures now own all the activities along the chain but integrate the supply network from various supplier networks and the ability to make fast and accurate decision often constitute a competitive advantage compared with the competitors or other networks (K.L. Choy, W.B. Lee and Victor Lo, 2003).Today's highly competitive environment is forcing the manufacturing organizations to establish a long-term effective collaboration with the efficient organizations.

As a result an effective supplier selection process is very important to the success of any manufacturing organization (Felix T. S. Chan, N. Kumar, M. K. Tiwari, H. C. W. Lau and K. L. Choy, 2008).The AHP has attracted the interest of many researchers mainly due to the nice mathematical properties of the method and the fact that the required input data are rather easy to obtain. Some of the industrial engineering applications of the AHP include its use in integrated manufacturing (Putrus, 1990).Multiple criteria decision making (**MCDM**) refers to making decisions in the presence of multiple, usually conflicting, criteria. **MCDM** problems are common in everyday life.AHP is a decision making technique. It provides a comprehensive framework for making multicritiria decisions by organizing problems into a hierarchical structure. It is a systematic procedure for representing the elements of any problem, hierarchically. It organizes basic rationality by decomposing a general decision problem in a hierarchical fashion into sub problems that can be easily comprehended and evaluated. Recently AHP has been proposed for application to qfd to generate the relative importance of the voice of customer. AHP is a powerful tool for problem solving and decision making in a complex environment.

1.1 The AHP – Applications

Since its discovery the AHP has been applied in a variety of decision-making scenarios:

● Choice – selection of one alternative from a set of alternatives.
● Prioritization/evaluation – determining the relative merit of a set of alternatives.
● Resource allocation – finding best combination of alternatives subject to a variety of constraints.
● Benchmarking – of processes or systems with other, known processes or systems.
● Quality management.

1.2 AHP Software

- Makeitrational.com
- Expert choice
- Transparent decision
- Bpmsg
- Super decisions

2. LITERATURE REVIEW

Many researcher have reviewed the developments of the Analytic Hierarchy Process (AHP) since its inception (Alessio Ishizaka and Ashraf Labib 2011). The Analytic Hierarchy Process (AHP) is a multi-criteria decision making (MCDM) method. The oldest reference that we have found dates from 1972 (T. Saaty, 1972). Then, a paper in the Journal of Mathematical Psychology (T. Saaty, 1977) precisely described the method. The vast majority of the applications still use AHP as described in this first publication and are unaware of successive developments. This paper provides a sketch of the major directions in methodological developments and further research in this important field.

Since its introduction, AHP has been widely used, for example in healthcare research(katharina Schmidt 2011),Flexible manufacturing system (Shang, J. and Sueyoshi, T. 1995),Machine selection (San, M. and Tab canon, M.T. 1994),selecting an automobile(Dae-Ho Byun 2000), industrial R&D project selection and resource allocation(M.J. Liberator 1987), Delphi method(R. Khorramshahgol, V.S. Moustakis 1988), Computer-aided machine-tool selection(Orlando Dura´n , Jose´ Aguilo 2008), evaluating machine tool alternatives(ZekiAya˘g · R.G. Özdemir 2006), Integrating fuzzy theory and hierarchy concepts to evaluate software quality(Che-Wei Chang . Cheng-RuWu . Hung-Lung Lin2008), product design in concurrent engineering (Xu L, Li Z, Shancang L, Fengming T, 2007). Issue resolution for conceptual design using AHP (Lin YJ, Huang CW, Tseng JC, Shiau JY,2004)

Selection of appropriate schedule delay analysis method (Adhikari I, Kim SY, Lee YD, 2006)

2.1 AHP – Theory

Saaty [1977] describes the seven pillars of the AHP as follows:

● Ratio scales, proportionality and normalized ratio scales.
● Reciprocal paired comparisons.
● The sensitivity of the principal right eigenvector.
● Clustering and using pivots to extend the scale.
● To create a one-dimensional ratio scale for representing the overall outcome.
● Rank preservation and reversal.
● integrating group judgments.

3. METHODOLOGY

The AHP encompasses six basic steps as summarized as follows:

Step 1. AHP uses several small sub problems to present a complex decision problem. Thus, the first act is to decompose the decision problem into a hierarchy with a goal at the top, criteria and sub-criteria at levels and sublevels of and decision alternatives at the bottom of the hierarchy

Step 2. The decision matrix, which is based on Saaty's nine-point scale, is constructed. The decision maker uses the fundamental 1–9 scale defined by Saaty to assess the priority score. In this context, the assessment of 1 indicates equal importance, 3 moderately more, 5 strongly more, 7 very strongly and 9 indicates extremely more importance. The values of 2, 4, 6, and 8 are allotted to indicate compromise values of importance.

The Fundamental Scale for Pairwise Comparisons		
Intensity of Importance	**Definition**	**Explanation**
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment moderately favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong importance	One element is favored very strongly over another; its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation
Intensities of 2, 4, 6, and 8 can be used to express intermediate values. Intensities of 1.1, 1.2, 1.3, etc. can be used for elements that are very close in importance.		

Table.1 Saaty scale

Step 3. The third step involves the comparison in pairs of the elements of the constructed hierarchy. The aim is to set their relative priorities with respect to each of the elements at the next higher level. The pairwise comparison matrix, which is based on the Saaty's 1–9 scale where A represents the pairwise comparison matrix, W the eigenvector and max the highest eigenvalue. If there are elements at the higher levels of the hierarchy, the obtained weight vector is multiplied with the weight coefficients of the elements at the higher levels, until the top of the hierarchy is reached. The alternative with the highest weight coefficient value should be taken as the best alternative If n(n - 1)/2 comparisons are consistent with n is the number of criteria, then the elements {aij} will satisfy the following conditions: aij = wi/wj = 1/aji and aii = 1 with i, j, k = 1, 2,. . .,n. In the comparison matrix, aij can be interpreted as the degree of preference of ith criteria over jth criteria. It appears that the weight determination of criteria is more reliable when using pairwise comparisons than obtaining them directly, because it is easier to make a comparison between two attributes than make an overall weight assignment.

Step 4. AHP also calculates an inconsistency index (or consistency ratio) to reflect the consistency of decision maker's judgments during the evaluation phase. The inconsistency index in both the decision matrix and in pairwise comparison matrices could be calculated with the equation: CI = (max – n) / (n – 1). The closer the inconsistency index is to zero, the greater the consistency. The consistency of the assessments is ensured if the equality aij - aik = aik holds for all criteria. The relevant index should be lower than 0.10 to accept the AHP results as consistent. If this is not the case, the decision-maker should go back to Steps 2 and 3 and redo the assessments and comparisons.

1	2	3	4	5	6	7	8	9	10
0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Table.2 Random Indices

Step 5. Before all the calculations of vector of priorities, the comparison matrix has to be normalized. Therefore, each column has to be divided by the sum of entries of the corresponding column. In that way, a normalized matrix is obtained in which the sum of the elements of each column vector is 1.

Step 6. For the following part, the eigenvalues of this matrix are needed to be calculated which would give the relative weights of criteria. This procedure is common in mathematics. The relative weights obtained in the third step should verify A .W = max .W

4. CONCLUSION

We have examined the history and development of AHP**.** This paper reviewed the growing body of work on AHP. We show that AHP has attracted the attention of scholars in various fields because of its ability to provide support to different decision-makers, in areas ranging from medical issues to computer science and environmental studies. Although numerous organizations in both the private and public sectors have already benefited from the use of AHP, there are far more organizations still unaware of a process such as AHP that is theoretically sound, understandable, and matches their expectations. We hope that this exposition will help in making these organizations aware of a viable alternative to applying inferior common simplistic strategies to important decisions.

References

1. Adhikari i, kim sy, lee yd (2006). Selection of appropriate schedule delay analysis method: analytical hierarchy process (ahp). In proceedings on picmet. Istanbul, turkey.

2. Alessio ishizaka and ashraf labib review of the main developments in the analytic hierarchy process, expert systems with applications, 38(11), 14336-14345, 2011.

3. Che-wei chang . Cheng-ruwu . Hung-lung lin(2008)integrating fuzzy theory and hierarchy concepts to evaluate software quality. Springer science+business media.

4. Felix t. S. Chan, n. Kumar, m. K. Tiwari, h. C. W. Lau and k. L. Choy, 2008 . Global supplier selection: a fuzzy-ahp approach, international journal of production research, vol. 46, no. 14, 15 july, 3825–3857.

5. K.l. Choy, w.b. Lee and victor lo, 2003. Design of a case based intelligent supplier relationship management system—the integration of supplier rating system and product coding system, expert systems with applications vol.25, pp 87–100.

6. Lin yj, huang cw, tseng jc, shiau jy (2004). Issue resolution for conceptual design using ahp. In proceedings of spie-volume 5605,intelligent systems in design and manufacturing. 25-26 october 2004. Philadelphia, usa.

7. M.j. Liberatore, an extension of the analytic hierarchy process for industrial r&d project selection and resource allocation, ieee transactions on engineering management em-34 (1), 1987, pp. 12±18.

*8. Orlando dura´n *, jose´ aguilo(2008), computer-aided machine-tool selection based on a fuzzy-ahp approach, expert systems with applications 34 (2008) 1787–1794.*

9. Putrus, p. (1990). Accounting for intangibles in integrated manufacturing (nonfinancial justification based on the analytical hierarchy process). Information strategy, 6: 25-30.

10. R. Khorramshahgol, v.s. Moustakis, delphic hierarchy process (dhp): a methodology for priority setting derived from the delphi method and analytic hierarchy process, european journal of operational research 37, 1988, pp. 347± 354.

11. Saaty, t. (1972). An eigenvalue allocation model for prioritization and planning. In working paper, energy management and policy center: university of pennsylvania.

12. Saaty, t. (1977). A scaling method for priorities in hierarchical structures. Journal of mathematical psychology, 15, 234-281.

13. Shang, j. And sueyoshi, t. (1995), "a unified framework for the selection of a flexible manufacturing system", european journal of operational research, vol. 85 no. 2, pp. 297-316.

14. San, m. And tabucanon, m.t. (1994), "a multiple-criteria approach to machine selection for flexible manufacturing systems", international journal of production economics, vol. 33 nos 1/3, pp. 121-32

15. Xu l, li z, shancang l, fengming t (2007). A decision support system for product design in concurrent engineering. Decision support systems. 42: 2029- 2042.

16. Zekiaya˘g · r.g. Özdemir(2006)a fuzzy ahp approach to evaluating machine tool alternatives.springer science + business media.